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TITLE: Converter for Satellite Communication Reception Simplified in Structure

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CONVERTER FOR SATELLITE COMMUNICATION RECEPTION SIMPLIFIED IN STRUCTURE

## BACKGROUND OF THE INVENTION

### 1. Field of the invention

The present invention relates to a converter for satellite communication reception for receiving mutually orthogonal linear polarized waves, and more particularly to the structure of the input parts of waveguides.



### 2. Description of the Related Art

Usually, where linear polarized waves of up to about 12 GHz in the frequency range of input signals are to be received by a converter for satellite communication reception of this kind, a pair of probes are arranged in mutually orthogonal directions within a waveguide, and a vertically polarized wave is coupled to one of the probes while a horizontally polarized wave is coupled to the other probe.

However, where the frequency range of input signals is as high as 20 GHz for instance, the problem of interference between the vertically polarized wave and the horizontally polarized wave becomes significant in the constitution above. Therefore, where linear polarized waves of an extremely high frequency range are to be received, the inside of the waveguide is branched into two paths, one for the vertically polarized wave and the other for the horizontally polarized wave, and polarized signals detected by probes are prevented from interfering with each other by coupling the vertically

polarized wave and the horizontally polarized wave to the probes in their respective propagation paths.

However, where the vertically polarized wave and the horizontally polarized wave are to be coupled to probes in two separate propagation paths as according to the prior art described above, usually each of the two probes is fitted to a separate circuit substrate, one circuit substrate being provided with a signal synthesizing means, and signals are transmitted from the other circuit substrate to the circuit substrate provided with the synthesizing means via a connecting section, because the electric field directions of the vertically polarized wave component and the horizontally polarized wave component are orthogonal to each other in the propagation paths. However, synthesis of signals detected by two probes using two circuit substrates not only makes the pattern and structure more complex but also involves the problems of increased signal losses and impossibility to reduce the interference sufficiently and, moreover, complicates the circuit substrate fitting work on account of the high frequency of the polarized signals.

There is also proposed an alternative according to which both probes are fitted to the same circuit substrate and an adapter provided to intervene between this circuit substrate and the waveguide aligns the electric field directions of the vertically polarized wave component and the horizontally polarized wave component into the same direction, but such an adapter would involve another problem that it is very complex

in structure and accordingly would prove to be a cost boosting factor.

## SUMMARY OF THE INVENTION

An object of the present invention, attempted in view of these problems involved in the prior art, is to provide a simply structured converter for satellite communication reception which can contribute to reducing signal losses and to simplifying the assembling work.

In order to achieve the above-stated object, a converter for satellite communication reception according to the invention is provided with a case having two waveguides in which linear polarized waves orthogonal to each other propagate, a circuit substrate fitted to this case and two probes disposed on this circuit substrate, wherein these two probes are arranged in the waveguides.

This configuration, as the mutually orthogonal linear polarized waves are coupled to their respective probes in the two waveguides of the case and signals detected by these probes can be amplified and synthesized on the same circuit substrate, not only can signal losses and interference be reduced but also the structure of the input parts of the waveguides can be simplified.

If, in the configuration described above, the two probes are composed of pin members and these pin members are supported by the circuit substrate by soldering or otherwise, the mutually orthogonal linear polarized waves can be securely coupled to

the pin members within the respective waveguides. In this case, if both pin members are formed in an L shape and a ground pattern provided on the circuit substrate is utilized as a reflective face for these pin members, the structure can be simplified even more.

Or, in the configuration described above, it is also possible to compose the two probes of electroconductive patterns provided on the circuit substrate and fit a short cap as a reflective face for these electroconductive patterns to the circuit substrate, and in this way it is also possible to securely couple the mutually orthogonal linear polarized waves to the electroconductive patterns within the respective waveguides.

## BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows the overall configuration of a converter for satellite communication reception, which is a first preferred embodiment of the present invention.

Fig. 2 shows a plan of the essential part of a case provided in the converter for satellite communication reception.

Fig. 3 shows a section along line 3-3 in Fig. 2.

Fig. 4 shows a plan of the essential part of a case provided in a second preferred embodiment of the invention.

Fig. 5 shows a section along line 5-5 in Fig. 4.

Fig. 6 shows a section along line 6-6 in Fig. 4.

Fig. 7 shows a plan of the essential part of a case provided in a third preferred embodiment of the invention.

Fig. 8 shows a section along line 8-8 in Fig. 7.

Fig. 9 shows a section along line 9-9 in Fig. 7.

Fig. 10 shows a section of the essential part of a case provided in a fourth preferred embodiment of the invention.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments of the present invention will be described below with reference to accompanying drawings. Fig. 1 shows the overall configuration of a converter for satellite communication reception, which is the first preferred embodiment of the invention; Fig. 2, a plan of the essential part of a case provided in the converter for satellite communication reception, and Fig. 3, a section along line 3-3 in Fig. 2.

As illustrated in Fig. 1, the converter for satellite communication reception embodying the invention in this mode is provided with a waveguide 1 whose inside is branched into two propagation paths 1a and 1b and a case 2 consisting of an electroconductive metallic material. Orthogonal bipolarized signals transmitted from a satellite are entered into the inside of the waveguide 1 through a horn 1c. Inside the waveguide 1 is arranged a short-circuit rod 3 and out of the orthogonal bipolarized signals entered into the waveguide 1, the horizontally polarized wave, for instance, is reflected by the short-circuit rod 3 to proceed in the first propagation path 1a, while the vertically polarized wave passes the short-circuit rod 3 to proceed in the second propagation path 1b.

As shown in Fig. 2 and Fig. 3, a circuit substrate 4 is fitted to the case 2, and a pair of probes 5 and 6 are supported by this circuit substrate 4 by soldering or otherwise. A converter circuit (not shown) including an amplifier, an oscillator and the like is mounted on the circuit substrate 4. The first probe 5 is a straight pin member while the second probe 6 is an L-shaped pin member, and the tips of the probes 5 and 6 extend into two waveguides 2a and 2b provided in the case 2. By integrating the waveguide 1 and the case 2 by fixing means such as bolts, the first propagation path 1a and the first waveguide 2a are let to communicate with each other, and so are the second propagation path 1b and the second waveguide 2b. In this establishment of communication, the tip of the first probe 5 extends in a direction parallel to the polarization plane of the horizontally polarized wave, and that of the second probe 6 extends in a direction parallel to the polarization plane of the vertically polarized wave.



In the converter for satellite communication reception configured as described above, when orthogonal bipolarized signals transmitted from a satellite are entered to inside the waveguide 1 through the horn 1c, the horizontally polarized wave is reflected by the short-circuit rod 3 to proceed from the first propagation path 1a to the first waveguide 2a, and reflected by the innermost wall of the first waveguide 2a to be detected by the first probe 5. On the other hand, the vertically polarized wave passes the short-circuit rod 3 to proceed from the second propagation path 1b to the second waveguide 2b, and

is reflected by the innermost wall of the second waveguide 2b to be detected by the second probe 6. The horizontally polarized signals detected by the first probe 5 and the vertically polarized signals detected by the second probe 6, after undergoing frequency conversion into IF signals by the converter circuit on the circuit substrate 4, are outputted via output terminals (not shown) provided on the case 2. Therefore, the orthogonal bipolarized waves, comprising the horizontally polarized wave and the vertically polarized wave, are coupled in the waveguides 2a and 2b of the case 2 to their respective probes 5 and 6, and the signals detected by these probes 5 and 6 can be amplified and synthesized on the same circuit substrate 4, making it possible to significantly reduce signal losses and interference and moreover to simplify the structure of the input parts of the waveguides.



Fig. 4 shows a plan of the essential part of a case provided in a second preferred embodiment of the invention; Fig. 5, a section along line 5-5 in Fig. 4, and Fig. 6, a section along line 6-6 in Fig. 4.

In this embodiment of the invention, the circuit substrate 4 is provided with electroconductive patterns as first and second probes 7 and 8, and short caps 9 and 10 consisting of an electroconductive metallic material as reflective faces for the two probes 7 and 8 are fitted to the circuit substrate 4 by soldering or otherwise. Further, within the case 2, the two waveguides 2a and 2b are bent at a right angle toward the short caps 9 and 10, respectively, and the tip

of the first probe 7 extends into a hollow surrounded by the first waveguide 2a and the short cap 9, while that of the second the probe 8 extends into a hollow surrounded by the second waveguide 2b and the short cap 10.

In the second embodiment of the invention configured in this mode, a horizontally polarized wave entered from the first propagation path 1a into the first waveguide 2a proceeds in the first waveguide 2a toward the circuit substrate 4 and is reflected by the short cap 9 to be detected by the first probe 7 on the circuit substrate 4. On the other hand, a vertically polarized wave entered from the second propagation path 1b into the second waveguide 2b proceeds in the second waveguide 2b toward the circuit substrate 4, and is reflected by the short cap 10 to be detected by the second probe 8 on the circuit substrate 4.

Fig. 7 shows a plan of the essential part of a case provided in a third preferred embodiment of the invention; Fig. 8, a section along line 6-6 in Fig. 7, and Fig. 9, a section along line 9-9 in Fig. 7.

This embodiment differs from the second embodiment described above in that L-shaped pin members are supported by the circuit substrate 4 as first and second probes 11 and 12 and that a ground pattern 13 provided on the surface of the circuit substrate 4 is used as the reflective face for the two probes 11 and 12. Thus, within the case 2, the two waveguides 2a and 2b are bent at a right angle toward the circuit substrate 4, and the tip of the first probe 11 extends into the first

waveguide 2a, while that of the second the probe 8 extends into the second waveguide 2b.

In the third embodiment of the invention configured as described above, a horizontally polarized wave entered from the first propagation path 1a into the first waveguide 2a proceeds in the first waveguide 2a toward the circuit substrate 4 and is reflected by the ground pattern 13 to be detected by the first probe 11 in the first waveguide 2a. On the other hand, a vertically polarized wave entered from the second propagation path 1b into the second waveguide 2b proceeds in the second waveguide 2b toward the circuit substrate 4, and is reflected by the ground pattern 13 to be detected by the second probe 12 in the second waveguide 2b.

Fig. 10 shows a section of the essential part of a case provided in a fourth preferred embodiment of the invention. This embodiment differs from the third embodiment described above in that both waveguides 2a and 2b are straight and that the circuit substrate 4 is arranged in an orthogonal direction to the axial centers of the waveguides 2a and 2b. Thus the tip of the first probe 11 consisting of an L-shaped pin member extends into inside the first waveguide 2a, while that of the second probe 12 also consisting of an L-shaped pin member extends into inside the second waveguide 2b, and the ground pattern 13 is provided on the surface of the circuit substrate 4.

In the fourth embodiment of the invention configured as described above, a horizontally polarized wave entered from the

first propagation path 1a into the first waveguide 2a proceeds straight in the first waveguide 2a and is reflected by the ground pattern 13 on the surface of the circuit substrate 4 to be detected by the first probe 11 of the first waveguide 2a. On the other hand, a vertically polarized wave entered from the second propagation path 1b to the second waveguide 2b proceeds straight in the second waveguide 2b and is also reflected by the ground pattern 13 to be detected by the second probe 12 in the second waveguide 2b.

The present invention can be embodied in numerous other variations than the embodiments described above. For instance, in the fourth embodiment shown in Fig. 10, the probes can be composed of electroconductive patterns instead of pin members, or a short cap may be used instead of the ground pattern as the reflective face for the probes.

The present invention, carried out in the modes described above, provides the following benefits.

A case having two waveguides in which linear polarized waves orthogonal to each other propagate, a circuit substrate fitted to this case and two probes disposed on this circuit substrate are provided, and these two probes are arranged in the waveguides. As the mutually orthogonal linear polarized waves are coupled to their respective probes in the two waveguides of the case and signals detected by these probes can be amplified and synthesized on the same circuit substrate, not only can signal losses and interference be reduced but also the structure of the input parts of the waveguides can be

simplified.